altogether to have coincided with that of the author, we have done so feeling that to pass over these points of difference would be to pay Mr. Pearson but a poor compliment. For we fully recognise the great value of the work in all essential matters, and we cannot but admire the energy with which a task of no ordinary difficulty has been carried to completion. Mr. Pearson has laid British botanists under great obligations, and has succeeded in producing a book that ought to serve to rescue from comparative though altogether unmerited oblivion a family, by no means the least interesting, of the vegetable kingdom. J. B. FARMER.

STRUCTURALLY ACTIVE MEDIA.

De la Double Refraction elliptique et de la Tétraréfringence du Quartz dans le Voisinage de l'Axe. Par G. Quesneville. Pp. xiv + 361 ; avec 4 planches. (Paris : Gauthier-Villars et Fils, 1898.)

THE peculiar phenomena exhibited by quartz in directions slightly inclined to the optic axis were explained by Airy in 1831 on the hypothesis that in any such direction two streams of permanent type can be propagated, these streams being oppositely and elliptically polarised with their planes of maximum polarisation respectively parallel and perpendicular to the principal section. With the aid of these assumptions, he calculated the forms of the interference patterns displayed in plane and circularly polarised light by plates of quartz perpendicular to the optic axis, and also discussed the remarkable phenomena that are observed when two such plates of equal thickness but of opposite rotations are superposed and traversed by a convergent stream of polarised light that is subsequently analysed. The close agreement between these calculated results and the experimental forms of the curves led to a general acceptance of Airy's views, and the conviction of their correctness has since been strengthened by experimental investigations of a more direct character.

This theory M. Quesneville, without disguising the magnitude of the task, has undertaken to refute, replacing it by a new one devised by himself. He maintains that the interference exhibited by plates of quartz in polarised light is in at least one important particular at variance with the results calculated by Airy, and claims that Jamin's investigations (the only experiments that he discusses), so far from confirming the accepted theory, actually lend support to that which he himself enunciates. Further, he alleges a theoretical objection to Airy's hypotheses. According to these there is, of course, a continuous change in the polarisation of the waves of permanent type as the position of their normal changes from a direction inclined to the optic axis to that of the axis itself, while it is the circular polarisation, and not the rotary phenomenon, that is the fundamental property of an active crystal in this latter direction. M. Quesneville, however, contends that Airy's formulæ involve a discontinuity in the phenomenon, inasmuch as a rotation of the primitive plane of polarisation nowhere occurs therein, for "s'il existe suivant l'axe, il est inadmissible que tout près l'axe, alors que les ellipses sont presque des cercles, elle ait disparu."

This idea is the key-note of his own theory, according to which the streams in an active crystal, propagated in a direction slightly inclined to the optic axis, only become of permanent type after a certain zone has been traversed within which a rotation of the plane of polarisation is "le phénomène primordial." On entry into the crystal, a beam of plane polarised light is supposed to be resolved into two elliptically polarised streams of opposite sign with their planes of maximum polarisation respectively parallel and perpendicular to the primitive plane of polarisation ; after a small distance has been traversed, these are regarded as having for their resultant a stream that is plane polarised in a new azimuth, while this is, again, equivalent to two fresh elliptically polarised streams ; this process is supposed to continue during passage through the first zone, within which the elliptic vibrations change both in form and in orientation. It is not clear what circumstances determine the limitation of the zone, but it is assumed that after a certain length of path, that diminishes as its inclination to the axis increases, the two elliptically polarised streams cease to occasion a rotation of the last plane of polarisation, and that they then enter the second zone, where each gives rise to two streams of the permanent type assumed by Airy. In this manner the four-fold refraction of quartz in the vicinity of the axis is arrived at ; there is, however, no assumption of more than two wave-velocities corresponding to a given direction, neither is there any recognition of a separation of the streams by refraction, so that the four elliptically polarised waves may be grouped together in pairs, the constituents of each group travelling with the same speed in the same direction, and there consequently is no question of a four-fold refraction, even if the author's contention be correct.

The limitation of this review precludes a discussion of the physical and mechanical difficulties involved in these ideas ; they are, however, sufficiently obvious. It is claimed that the theory is not merely kinematical, but that it represents the actual state of things that occurs during the passage of light through a plate of quartz, though its author confesses his inability to formulate any hypothesis respecting the distribution of the ether round the axis of an active crystal from which it could be deduced.

The book in which this theory is expounded is divided into three sections, preceded by an introduction giving a sketch of the plan and scope of the work. In the first section the author discusses some investigations prior to his own. MacCullagh, in 1836, showed that the addition of certain terms to the differential equations of motion for inactive uniaxal crystals would lead to the elliptic polarisation assumed by Airy. Starting from a mistaken conception of the significance of these equations, M. Quesneville professes to show that "Convenablement interpretées," they prove that

> "Il existe dans le quartz une première zone pendant laquelle les rayons dès l'entrée donnent lieu à la rotation du plan primitif de polarisation, non seulement suivant l'axe, mais obliquement à l'axe jusqu'à la périphérie."

He then proceeds to a discussion of Jamin's experiments, deducing therefrom the result that in calculating the difference of phase between the two oppositely polarised

streams, introduced by passage through a plate of quartz, only the distance travelled in the second zone is to be taken into account. It may at once be conceded that Jamin's results do not afford a very striking confirmation of Airy's theory, which may in great measure be attributed to the experimental methods that he employed; but M. Quesneville in his criticism does not appear to have sufficiently recognised the distinction between the phase-difference of the streams on emergence into air and that of the rectangular plane polarised components of the resultant elliptically polarised train of waves.

In the second section we have the author's own experimental investigations, that were made with double prisms of quartz cut in different directions with respect to the optic axis and arranged in the shape of rectangular parallelopipeds. When the primitive polarisation is circular, M. Quesneville's theory leads to the same final results as that of Airy, but a divergence occurs when the initial polarisation is plane. Consequently it is found in accordance with both theories that if the light traverse the first prism along the optic axis and its path in the second be inclined to this direction, the emergent pencils can be completely quenched by means of a quarter-wave plate and an analyser; on the other hand, with a pair of prisms, such that the direction of propagation of the light was in the first perpendicular to the optic axis and in the second inclined to it at an angle varying from 5° to 9°, M. Quesneville was unable to obtain complete extinction of the emergent streams either with an analyser alone or with a quarter-wave plate and analyser, whatever might be their orientations. He thence deduced the inference that each pencil is formed of two elliptically polarised streams of opposite rotations that, having traversed the quartz with the same velocity, remain superposed on emergence, and on this experiment he relies for his proof of the four-fold refraction of quartz near the axis. It is noteworthy that this result was only obtained with small prisms, a fact for which a very inadequate explanation is offered.

The last section is devoted to a discussion of the rings produced by plates of quartz in polarised light. Two instances must suffice to show the manner in which Airy's formulæ are treated. On p. 280 it is argued that these would give the so-called quadratic curves even when the initial and final planes of polarisation are parallel, the fact being overlooked that the term that introduces this form of the curves has a factor that is then equal to zero; and on p. 341 the result that in the same circumstances the circles in white light would be black instead of coloured is deduced by equating to zero a sum of essentially positive terms. This section, however, contains several points of interest, the most important being the question whether or no circles exist in conjunction with the phenomenon known as Airy's spirals. In the photographs published in the book these circles do not appear, though they are present in those given by other authors. A question therefore arises as to the accuracy of the plates employed by M. Quesneville, but if his contention be proved it must be recollected that Airy's result is confessedly only approximate, and it is possible that a more complete investigation would lead to a formula giving spiral curves alone.

The book is wanting in the clearness of exposition that we are accustomed to expect from a French writer on a physical subject, and it is a matter for regret that the author, in his anxiety to make a strong case for his own views, should have permitted himself to repeatedly accuse Verdet and other physicists of "prudently passing over in silence" facts that tell against the theory that he is attacking.

ELEMENTARY PHYSICS.

A Text-book of Physics, with Sections on the Applications of Physics to Physiology and Medicine. By R. A. Lehfeldt, D.Sc. Pp. 304; 112 figures. (London: Edward Arnold, 1902.) Price 6*s*.

A COMPLETELY new arrangement has been adopted in this book in the order in which subjects are presented to the student. The traditional order of the text-book of physics has been abandoned, in many cases with advantage, but often a student will be sadly at loss in consequence. He will find it hard to fathom the object of proving (p. 81) that the elasticity of a gas is equal to its pressure before he is familiar with the idea of the elasticity of liquids (p. 85) or of solids (p. 130), and he can derive little help in his efforts by being given for the time being the definition of "constant ratio of stress to strain" when the immediate object is to prove that it is not constant, but equal to the variable p. The study of gases alone would never have suggested attaching importance to the ratio of stress to strain.

Again, to take another example, the subject order adopted involved introducing in connection with conductivity of heat (p. 72) the question of the anomalous expansion of water described later (p. 90).

Likewise, in treating of electrolysis (p. 188), the term electrical charge is used without explanation. In the order adopted this does not appear until p. 249.

Of course, it is not always possible to avoid such anticipations. Students often, however, in consequence fancy they do not understand the point in hand, when it is really the anticipation which is troubling them.

In the order of the chapters, "Heat" comes before "Properties of Fluids," and next comes "Properties of Solids." Sometimes the analogies adopted in consequence come quaintly to one accustomed to the old traditional order of things, and are apt to appear upside down, as the analogy taken from conductivity of heat to help the reader to grasp the idea of flow in liquids.

The work contains a vast number of distinct things for its size. Scarcely any branch of physics is omitted, but it is a question whether there is not too much in the book and whether less matter more carefully arranged would not have better chance of sticking. We must avoid giving our students mental indigestion from overloading. There is an unpleasant feeling throughout of being rather rushed, and that nothing must be left out which the external examiner may perchance alight on in setting the paper. Perhaps the fault, if it be one, may not lie with the book.

The attractions and repulsions of currents appear to be no further alluded to than in the statement describing the Kelvin current balances, that "of the two fixed coils on the right, one attracts the movable coil